A Review of

The Effectiveness of

Software Project Management Training

Overall Conclusion

The Software Quality Institute's (SQI) Software Project Management (SPM) certificate program training enhances the project management skills of state agency software developers. Of the six subject areas evaluated, these enhancements have been most strongly reported in the performance of inspection activities (i.e., review of artifacts, code, and processes) and in the use of documented plans. Managers of graduates of the training also reported benefits of the training, as did clients of the training graduates – to a lesser extent.

Other Observations Include:

- A review of pay actions for SPM graduates indicated that training does not appear to increase the likelihood that graduates will receive pay increases.
- The turnover of SPM trainees for fiscal years1997 and 1998 is not disproportionately high compared to turnover of other information technology professionals.
- Other factors in addition to the training were identified as helpful in applying training concepts to the workplace.

Responses Indicate That Project Management Has Improved

Information gathered from software project management (SPM) training graduates, their managers, and their clients indicates that project management skills improved as a result of the training. Of the state agency graduates who responded to our questionnaire, almost all reported that the training caused a change in their method of project management. All of the managers interviewed considered the training to be beneficial. Half of the clients interviewed described benefits from the training. Significant changes in methods of project management vary; however four primary areas of behavior change were identified from the questionnaire responses.

Respondents Report Positive Changes In Project Management after Training

Thirteen of fourteen state agency respondents (93%) reported that the training caused a change in their method of project management. The following are among graduates' responses*:*

Respondents' Comments

> *Among other things* [the training] *caused me to focus more on processes with a strong emphasis on repeatability and process improvement*
>
> *…* [the training] *helped us in formalizing the methods with artifacts. It became a more repeatable process and allows us to have a common vocabulary.*
>
> *… I now understand the importance of planning the project. Getting all stakeholders on board as to what the objective is imperative to the success of the project. The use of a WBS* [work breakdown structure] *enables me to know what is to be done, what has been done, are we on time, are we on budget… Risk management is important in any type of project… Inspections are a good way to detect defects in products before the project is actually implemented/published.*

Training Enhances Ability to Deliver Expected Functionality

Eleven of fourteen respondents (79%) responded affirmatively when asked if SPM training improves their ability to deliver expected functionality. Those who responded negatively cited the course's emphasis on 'theory' or users' inability to communicate needs as reasons why the SPM training had not resulted in improved ability to deliver expected functionality.

Respondents' Comments

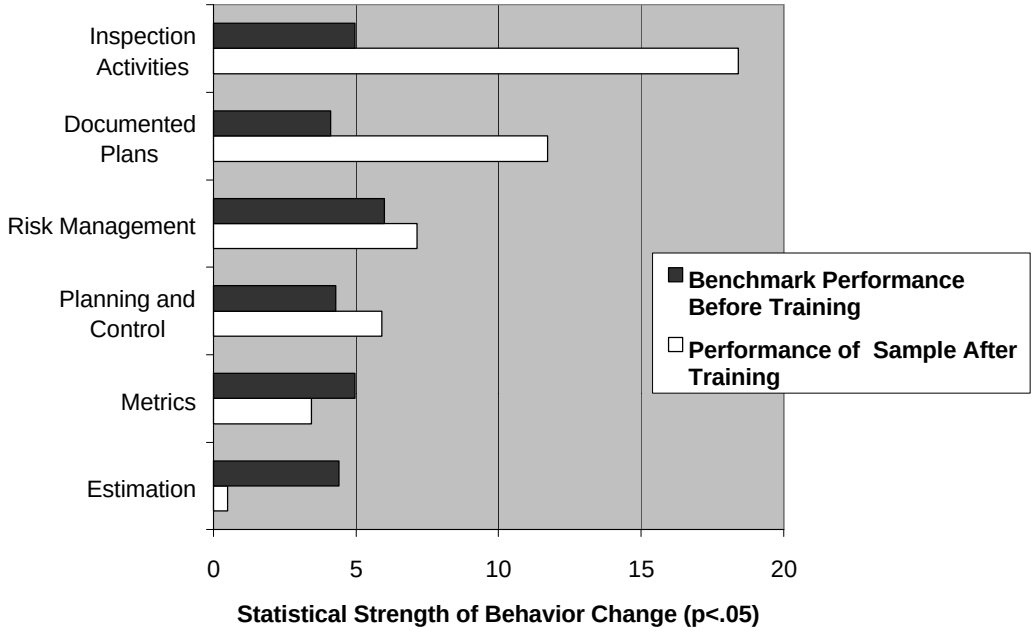
> *Using the WBS* [work breakdown structure] *and focusing in on the analysis phase seems to bring into focus the needs of a project, as opposed to the wants of a project.*
>
> *Using such documents as the SRS* [software requirements statement] *and SDD* [software design document] *as well as using processes such as inspections has increased my ability to deliver what is expected by the customer. Tying requirements to design points allows me to know that I have covered each requirement.*
>
> *The techniques learned in SPM classes are designed to ensure and foster the development of quality product that are delivered on time and within budget. Using the Project Management Plan, SRS, SDS, QA* [quality assurance] *Processes and other PM* [project management] *tools better ensures the delivery of expected functionality. Strong emphasis on customer and end-user interface is another critical success factor.*

Graduates Report Behavior Changes In Four Of Six Subject Areas

State graduates reported a statistically significant change in behavior in four of the six subject areas evaluated. These four areas are:

1. Inspection Activities
2. Documented Plans (such as a statement of work, software requirements statement, software test plan, etc.)
3. Risk Management
4. Planning and Control Techniques

Statistical Significance of Behavior Changes by Training Subject Area



[Note: When the index for the performance of the sample (respondents) after training is greater than the benchmark performance before training, a statistical difference in before and after behavior exists.]

The areas of the most significant change were performance of inspection activities (inspection of artifacts, code, processes) and use of documented plans.

Prior to the training, an average of 34% of respondents reported use of inspection activities “sometimes” or “most of the time”. After the training, 78% of the respondents reported use of the activities at the same frequency.

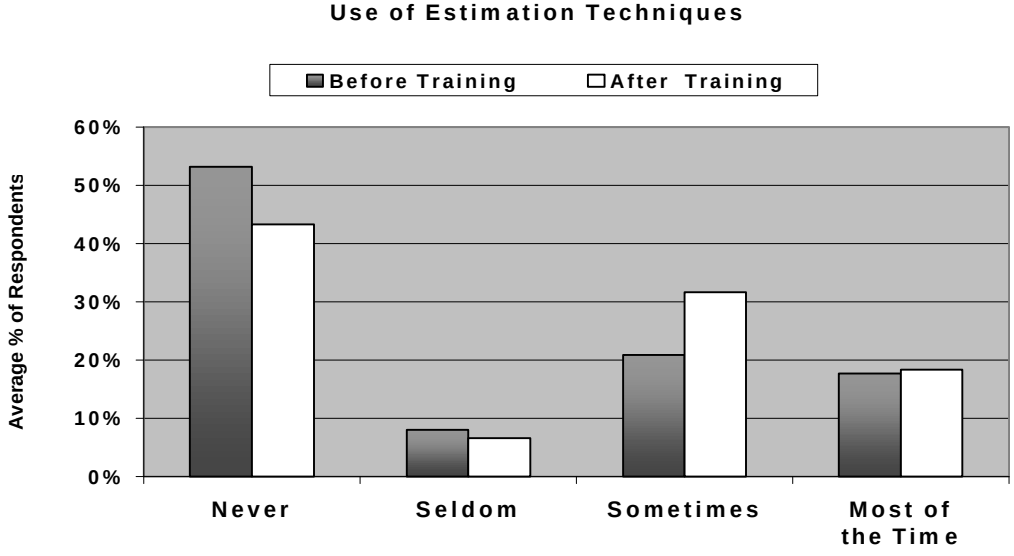
The document that the greatest number of respondents use most frequently is the Software Requirements Statement (SRS), a formal document to capture information requirements in a structured manner. The SRS is also the document that all state agency respondents considered very important to a project’s successful completion.

The next most frequently used document is the Software Test Plan. This likewise was the document respondents considered second most important to a project’s successful completion.

Respondents’ Behavior Did Not Change Significantly In Two Areas

No statistically significant behavior changes were noted in the use of estimation techniques or metric selection and implementation after training.

Even though 79% of the respondents reported that estimation techniques were important or very important to successful completion of software project management, there was no significant change in use of estimation techniques before and after the training. The most common method of estimation – before and after training - was the rule of thumb method.



[This graph represents the average percentage of respondents who reported that they "regularly" or "most of the time" used estimation techniques before the training versus after the training.]

Additionally, 71% of the respondents reported that organizational or cultural barriers somewhat or substantially inhibit implementation of effort estimation techniques.

Respondents' Comments

> *Executive management does not understand that most estimation techniques are based on metrics collected from past projects. If the metrics do not exist, one must fall back on Delphi or industry standards. In addition, estimates at the beginning of a project may have an error factor of plus or minus 300% (an industry standard). Project Managers are expected to accurately predict estimates without detailed information.*
>
> *Cultural barriers as well as lack of qualified SMEs* [subject matter experts] *affect the estimation techniques. We don't rely on lines of code, and we've just begun using function points. We generally base our estimates on past projects (and not with any historical data – just the rule of thumb approach – "I remember it taking 12 months to do something similar" – as opposed to some hard data.)*
>
> *Both COCOMO and function point estimation techniques are new to the organization. Everyone will need to be trained and mentored in order to use these techniques. We are fully loaded with projects like Y2K and legal mandates which do not allow extra time to learn new techniques.*
>
> *It appears that implementation dates are provided when the projects are assigned or requested by the customers. This is changing gradually in a positive manner.*

Regarding use of metrics, respondents considered project progress metrics to be the most important metric for software project management. There was not a statistically significant difference in the aggregate use of metrics for project progress, product quality, and process compliance. However, all respondents reported that they used project progress metrics "some of the time" or "most of the time" after attending training (as opposed to 57% before the training).

Trainees' Managers View the Training as Beneficial

All six managers interviewed from four different agencies considered the training to be beneficial. Managers most commonly cited the following benefits from the training:

- Increased emphasis on preparation of plans (SRS, test plans, etc.)
- More attention to process improvement and software quality processes

- Increased understanding of the importance of why software project processes and procedures are meaningful

Managers' Comments

> *I absolutely love it* [the SPM training].
>
> *They* [SPM training graduates] *understand the broader role of a project manager, whereas those who don't have training view it in limited scope*.
>
> *The training changes their* [the SPM training graduates] *whole outlook about how a project should be managed*.

Managers at all agencies reported some barriers to implementation in the workplace of concepts learned in the training, including:

- Much work to do and not enough staff
- Data processing staff's reluctance to change
- User lack of integration in the learning

Finally, managers offered the following suggestions for the training:

- Greater results may be obtained from short-term training focused on a particular topic.
- Agencies could develop a commitment-to-work agreement for employees wanting to take the SPM training.
- There should be more marketing of the classes and benefits of SPM training to the business/user community.

Some Clients Are More Satisfied With Training Results Than Others

Three of six clients interviewed at three agencies commented on benefits in software project management resulting from the SPM training. Benefits cited included the following:

- Increased preparation of documented plans (particularly the Software Requirements Statement)
- Increased involvement and participation of the clients in the software development process (particularly in requirements definition and testing)
- Process development (new or updated methodologies at two agencies)

At one agency in particular, clients reported not having their expectations met for the training. They reported that they had not seen significant changes in the performance of software project management.

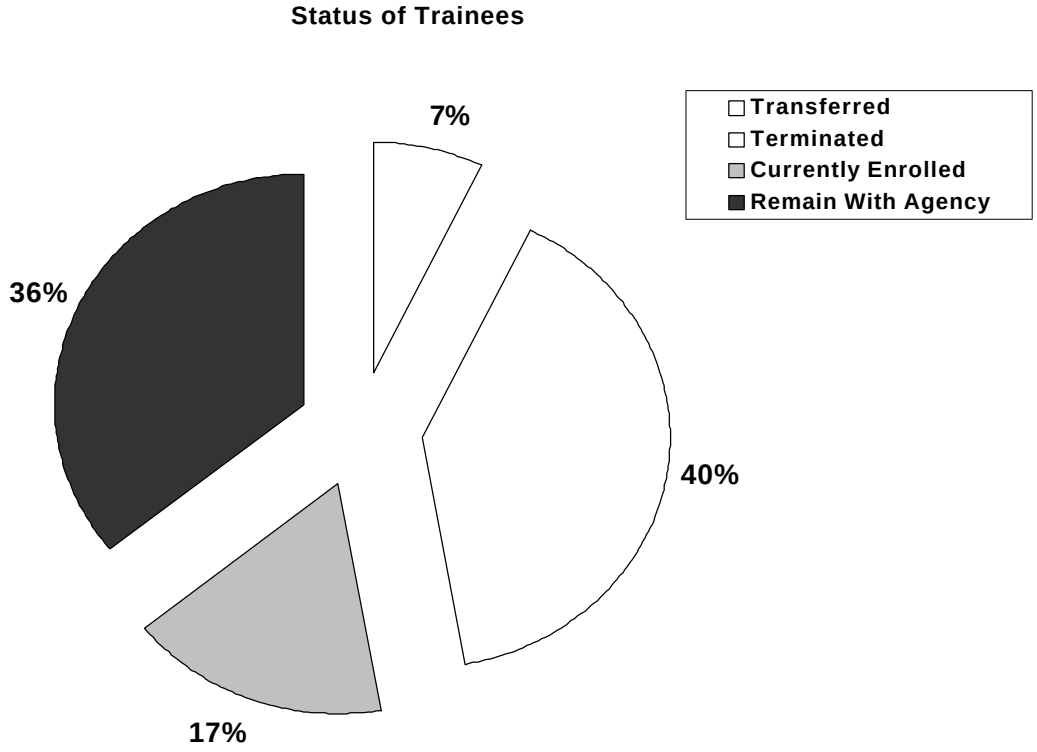
Other Factors Contribute to Effectiveness of Training

Several factors were reported as helpful in enabling application of training concepts to the workplace. Factors considered to be helpful included the following:

- Multiple persons cited the need for active management support of information resources departments' efforts to implement new procedures.
- Employees from some agencies expressed the importance of providing user training to enable users to understand and better participate in the new procedures. One agency offers on-going training of its methodology for users.
- Several agencies had either a "champion" for software project management/quality assurance improvement or a designated individual to spearhead process improvement activities.
- Agencies with multiple graduates of the SPM program appeared to have an advantage in that more developers "understood" the need for and supported changes in project management techniques.
- Some agencies were aware of the Capability Maturity Model (CMM) and planned to link adoption of process improvement procedures with movement from one CMM level to the next.

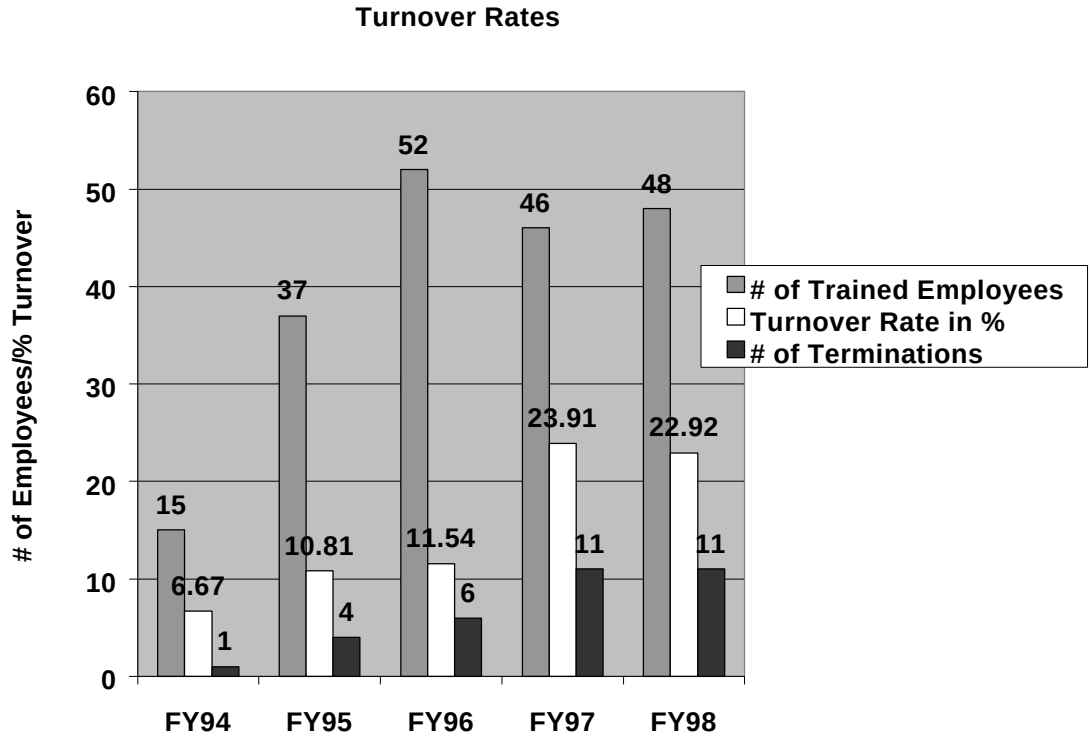
Turnover of SPM Trainees Does Not Appear to be Disproportionately High

Eleven agencies have sent 70 employees to the training during fiscal years 94 through 98. Of these 70 employees, 57 have graduated, 28 have terminated from state employment, 5 have transferred to other agencies, and 12 are currently enrolled in the training. [Note: Thirteen state employees were originally



enrolled in the current training session, however one terminated mid-way through the session.]

Even though the aggregate SPM turnover for graduates between FY 1994 through FY 1998 is 40%, the turnover rate per fiscal year has only ranged from 7% to 24%. [Note that the aggregate turnover rate is 47% if counting employees who transferred to other agencies as "terminated" employees.]



[Note: This data represents both employees who have graduated and those who are currently enrolled in the training.]

The turnover rate for the SPM trainees peaked in fiscal year 1997 at 23.91%. The statewide turnover for all information systems professionals (including non-software development staff) in fiscal year 1997 was 19.66%. The State Auditor's Office, in *An Annual Report on Full Time Classified State Employee Turnover for Fiscal Year 1997* (Report No. 98-703) acknowledged the overall high turnover of information professionals and reported the following:

> *The dynamic marketplace for Information Technology professionals makes recruitment and retention of these individuals especially difficult for the State. These positions are usually involved in high-priority projects which makes turnover especially trying.*

The statewide turnover for all information systems professionals remained relatively consistent in fiscal year 1998 at 19.84%. There is no statistically significant difference between the turnover rate for information systems professionals and SPM trainees for fiscal years 1997 and 1998.

Turnover information from the information resource departments of three agencies (who have sent 71% of the state agency employees to the training) was obtained for fiscal years 1996 through 1998. This information was combined and compared to the combined turnover rates of the graduates from the same agencies. A statistically significant difference between the turnover rates for the graduates and the information resource departments did not exist for fiscal years 1997 and 1998. In 1996, the training graduate turnover rate was statistically significantly lower than the information resource department turnover rate.

Training Does Not Appear To Increase the Likelihood Of Pay Actions

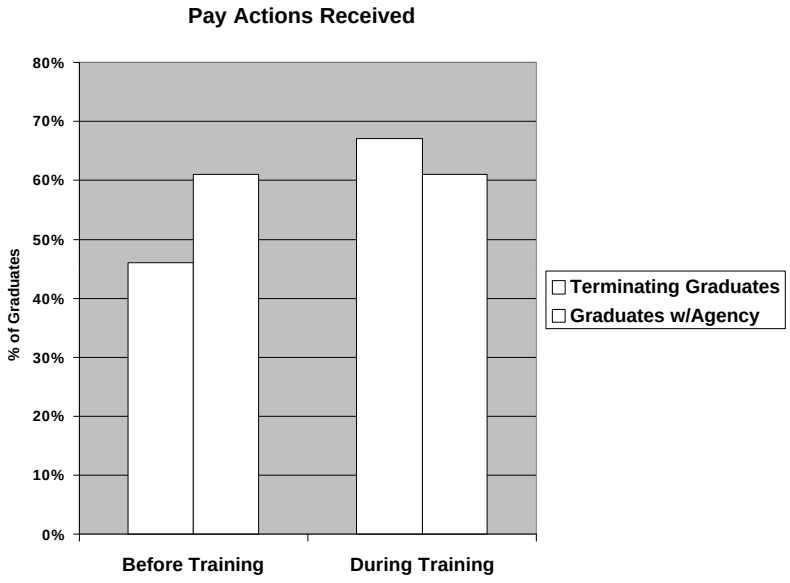
There is no statistically significant difference between the rates graduates received pay actions before the training versus the rate at which they received pay actions during or after the training. Therefore, it appears that the training does not result in additional pay actions.

We reviewed the pay actions for graduates from the four agencies that employed 89% of the graduates. We found the following:

- 55% of graduates received pay actions within the 14 months prior to the start of the training
- 64% received pay actions during the (14-month) training period
- 54% received pay actions within 14 months after the completion of the course

Additionally, there was no statistical difference between the pay action rates before and during training for terminating employees and for those employees remaining in state employment.

- Of terminating employees, 46% received pay actions prior to the training and 67% received a pay action during the training
- Of employees remaining with the state, 61% received pay actions prior to the training and 61% received pay actions during the training



Project Management Training Is Obtained From Other Sources

Six of seven agencies and universities not involved with the Software Quality Institute's SPM training offer their staff some type of formal project management training. This training includes self-study computer-based courses, in-house training classes, on-site and off-site training provided by outside sources, and reimbursement for college-level courses.

Three of the seven agencies and universities also rely on on-the-job training. This consists of partnering with vendors on projects, explanation, and on-the-job use of Microsoft Project Manager.

One agency does not offer training because they already have "very senior,

Respondents from four of the seven agencies and universities consider their training to be effective. Two of the seven said that the quality ranges from effective to less effective. One respondent said that most learning takes place by actually performing the work on the job, not through classroom training.

Reasons Why Some Agencies and Universities Don't Use the SQI SPM Training

- Training budgets are limited.
- The length of the training is too long (and, therefore, staff won't commit to attend).
- Travel requirements are difficult for those agencies and universities located outside of Austin, Texas.
- Lack of awareness of SQI training.
- Belief that there would not be enough of a pay-off from the training because project managers do not manage projects all the time.

Non-State Agency Results Are Similar To State-Agency Results

Responses from 15% of the non-state agency SPM graduates surveyed indicated that their impressions and experiences with the SPM training were similar to those of state agency graduates of the training.

The Majority Of Non-State Graduates Report That The SPM Training Caused Them To Change Their Methods Of Project Management

Six of ten non-state agency graduates (60%) reported that the training caused a change in their method of project management. One in ten (10%) did not think the training impacted methods of project management. Comments regarding the non-state agency graduates' changes in project management include the following:

Non State-Agency Graduates' Comments

> *We began requiring project plans, requirements documents, test documents.*
>
> *Demanded adherence to a disciplined software development process.*
>
> *Implementation of basic risk analysis, inspections, and testing.*
>
> *Now we do Delphi estimations and try to schedule our workload. We are much harder on feature creep. We are more committed to our deadlines.*

Non-state agency graduates reported a statistically significant change in the behavior in two of the six subject areas that we evaluated. The areas where the graduates reported a change were the following:

1. Inspection Activities
2. Documented Plans

These were also the areas of the most significant change for the state agency employees.

Suggestions and Conclusions

1. Software project management training – of one sort or another - should be encouraged for developers of state applications.
2. Agencies who would like to improve their software quality processes should consider:
   - Designating staff responsible for software quality process improvement
   - Sending information resources management to an abbreviated course in software project management so that they can "buy in" and support the process
   - Developing a "critical mass" of persons who have received project management training as quickly as is feasible
   - Developing commitment to work agreements for staff who receive extensive training
   - Creating opportunities to allow trained staff to apply the concepts they have learned to their workplace assignments.
   - Performing their own evaluations of the benefits and effectiveness of the SQI software project management training.
   - Considering additional compensation for graduates of the training based on their demonstrated improvements in project management skills.

Appendix 1:
Objective, Scope, and Methodology

Objective

Our objective was to determine whether the State benefits from attendance in software project management (SPM) training. Specifically, we wanted to determine if trainees' software project management practices improved as a result of the training.

The Quality Assurance Team (QAT) had promoted the benefits of this training and requested the State Auditor's Office to determine if the training was beneficial.

Scope

This project focused on state agency trainees who had attended a fourteen month SPM certificate program offered by the University of Texas Software Quality Institute (SQI). Information was not gathered from trainees of other software project management training courses.

Although the SQI SPM training covers many topics, the following six subject areas were chosen for the review of before and after training behavior:

- Inspection Activities
- Documented Plans
- Risk Management
- Planning and Control Techniques
- Metrics
- Estimation Techniques

In addition, information was also collected on turnover and pay action histories of state agency trainees, and on before and after training practices of non-state agency graduates of the SQI SPM training.

Methodology

The methodology used on this project consisted of collecting and analyzing information.

State agency SQI SPM graduates from two agencies were interviewed to gather initial information about the training.

We then developed a questionnaire asking training graduates about their pre- and post-training use of techniques from six different subject areas. This questionnaire was distributed on-line with assistance from Catapult, Inc. to both state employee and non-state employee training graduates. The on-line questionnaire was sent to 23 state agency graduates who remain employed with the state. We received responses from 14 of the 23

state agency graduates (61%). Ten of sixty-five (15%) non-state agency graduates responded to the on-line questionnaire.

While hypothesis tests and analysis of variance were used to determine if pre- and post-training behavior changes were statistically significant, the small number of graduate respondents who remain with the State make these analyses more preliminary and exploratory than definitive and confirmatory. Additional future research may be needed to verify the results noted.

Interviews were also conducted with both managers and clients of state employee graduates to gather more information about the effects of the training on graduates' project management practices.

For the turnover analysis, state employee start data and termination data was gathered from the Human Resource Information Systems. Agencies also provided data on turnover within their Information Resources Departments.

We also performed an informal phone survey of four agencies and three universities with large information resources expenditures to identify if they provide their staff with software project management training.

Background

- SQI has offered eight sessions of software project management training beginning in September, 1993.
- Eleven agencies have sent 58 employees to the training in the past. Fifty-one of these employees (88%) have come from four agencies.
- Currently, six state agencies have 13 employees enrolled in the training program.
- The training program is presented in six modules and lasts approximately 14 months. The government rate for the SPM program is $5,688 (or $948 per module).

Other Information

The following members of the State Auditor's Office performed work on this project:

- Sandy Bootz (Team Leader)
- Odafe Okiomah
- Bruce Truitt, MPAff (Quality Control Reviewer)
- Ed Pier, CISA (Project Manager)